Manitoba Surface Water Quality Objectives

A Water Standards and Studies Report

Manitoba
Environment and
Workplace Safety
and Health

Manitoba

Minister of
Environment and
Workplace Safety and Health

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Dear Sir/Madam:

I am pleased to present a report prepared by my Department entitled "Manitoba Surface Water Quality Objectives". This document contains objectives, principles and policies that will be used to protect the water quality in Manitoba's numerous streams, lakes, marshes and other bodies of water. It is intended that this information be used by federal, provincial and municipal agencies, industries, developers and others to assist project planning and to assist the preparation of environmental assessments under the Manitoba Environment Act 1988 for those activities or developments that may have the potential to unacceptably impair surface water quality. These objectives, principles and policies will subsequently be used by the Department to assist in the development of licences under this legislation.

The attached document has been thoroughly reviewed by scientific, technical and lay persons, representatives of other Manitoba government departments, municipal and industrial corporations, consulting firms, the Clean Environment Commission plus others. Revisions will continue to be made in the future to ensure the document reflects current scientific knowledge.

The thoughtful use of this information will protect our valuable surface water quality resources, while allowing the necessary development for Manitoba's continued social and economic growth.

Yours sincerely,

E Connery

The Honourable Ed Connery, Minister
Environment and Workplace Safety and
Health

MANITOBA SURFACE

WATER QUALITY OBJECTIVES

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Safety and Health

A Water Standards and Studies Report

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SUMMARY

The surface waters of Manitoba are used for numerous purposes including domestic consumption, industrial uses and agricultural purposes such as irrigation and livestock watering. In addition, many surface waters are used for recreational pursuits such as swimming, water skiing, boating and the enjoyment of pleasant scenery. Most waters are also inhabited by fish life, amphibians (frogs), reptiles (turtles), aquatic insects and algae. Large forms of wildlife, small furbearing mammals, waterfowl and some birds of prey rely upon surface waters for drinking purposes, habitat and sources of food supplies.

The quality of surface water has the potential to become degraded through many other legitimate but sometimes conflicting uses such as the disposal of industrial and municipal effluents, development of hydroelectrical generating sites and land-use practices such as agriculture and forestry.

In order to achieve harmony between the various uses, surface water quality objectives were developed which define minimum levels of quality for each of the uses that requires protection. The objectives, when not exceeded, will protect an organism, a community of organisms, a prescribed water use, or a designated multiple purpose water use with an adequate degree of safety. Specific objectives have been developed for over eighty substances.

These objectives affect all Manitobans, since if they do not offer adequate protection, surface water quality may become degraded. Conversely, if they are too restrictive, an unnecessary burden may be imposed on taxpayers and industry in order to pay for additional waste treatment facilities.

Surface water quality objectives are primarily used by government agencies, such as the Department of Environment and Workplace Safety and Health, in order to assist in developing effluent discharge restrictions for industrial and municipal waste discharges. Similarly, developers can use these objectives in planning processes. With information on downstream water uses, existing water quality characteristics and stream discharge volumes, predictions can be made regarding the treatment costs likely to be associated with any specific location. Although this is the principal role of surface water quality objectives within Manitoba, they may also be used for other purposes. For example, the objectives may be used to assist in developing strategies to control land-use practices that may have effects on water quality, such as cottage development. The objectives may be used in combination with environmental monitoring programs to assist in assessing the quality of our surface water resources. The objectives may also be used to assist in determining if certain waters are suitable for uses such as irrigation.

In cases where the objectives are exceeded, the Department of Environment and Workplace Safety and Health may conduct the necessary studies in order to determine the cause of the pollution. Should the cause be waste effluents, direct regulatory enforcement action could not be taken. Rather, existing discharge licences may be revised to provide the necessary degree of protection.

These objectives are intended to apply to conditions in water that are caused by man's activities. Waters may have natural characteristics outside certain objectives. In such cases, the objectives for those charateristics do not apply. However, if a certain parameter exceeds its objective due to natural conditions, it would be unwise to further increase that parameter by man-made activities, unless such additions would not jeopardize any beneficial use as shown through site-specific investigations.

It is important to realize that scientific information is limited on all the possible effects of a pollutant in the environment. New information, however, is continually being reported. Thus, the objectives must be revised periodically in order to include the most recent scientific knowledge. Based upon the available information, these objectives are designed to afford adequate protection without being unreasonably restrictive yet providing an adequate degree of protection. However, while these objectives are appropriate for most applications within Manitoba, objective modifications may be required at some unique sites. Modifications of objectives could be required for example, to account for the lower or greater sensitivity of resident aquatic species.

Objectives have not been developed for all possible substances that could affect water quality. Manitoba's surface waters could potentially be contaminated with virtually hundreds of substances. These include, for example, agricultural chemicals, or hazardous goods that may be transported through Manitoba. However, given reasonable information that such substances are present, objectives will be developed using the best available scientific information.

Because specific numerical objectives cannot reasonably be developed for every possible chemical, physical or biological parameter, general statements concerning environmental quality are also used to protect water quality. These requirements, although written in general terms, are nevertheless water quality objectives. For example, these may be used to establish effluent limits even though there may be no specific numerical objectives applicable in the receiving water. General statements have been developed for colour, odour, taste, turbidity, deposits, floating materials, flow, litter, nutrients, oil and grease and toxic substances.

Ideally, objectives should be maintained at all times. It is however, generally accepted that to require objective maintenance at all times is unreasonable. Thus, a specific low flow level has been chosen below which the objectives do not have to be met in most streams. This

flow, for large streams and rivers, is the average minimum flow which, on a statistical basis, would occur for a seven consecutive day period once every ten years. For small intermittent streams this minimum flow is 0.003 m^3/s. However, the flows in many streams in southern Manitoba are regulated by control structures. The minimum flows for these streams are often determined based upon the operating policy of the Water Resources Branch, Department of Natural Resources. The objectives should be maintained at all times in lakes.

Mixing zones are areas adjacent to a discharge, where the stream or lake may not meet all the water quality objectives. This is allowed for practical reasons, since for most pollutants, it would be unreasonable to expect the objectives to be met at the end of the discharge pipe. Mixing zones are therefore recognized as areas subject to a loss of value. Nevertheless, certain guidelines should be followed to ensure that the loss is kept as small as possible. These include, for example, ensuring that the entire width of rivers are not completely influenced by a discharge in such a manner that fish movement is prohibited or that bathing areas are not included in mixing zones.

Certain pristine waters support important major uses, such as recreation on surface waters within Provincial Parks. These waters may be given a "High Quality" designation. It is the intent that discharges or other activities that may affect the water quality of these areas should be very strictly controlled. Thus, development within "High Quality" surface water areas will likely be more costly than in other areas of the Province, since all available measures should be used to control environmental disturbances.

Some pristine waters of the Province may be preserved in their natural state for the future. These waters may be given an "Exceptional Value" designation. Development of any type that may affect water quality should be discouraged from these areas.

Objectives have been developed for each of the general surface water uses within Manitoba that requires protection. These are designated as classes and include domestic consumption, aquatic life and wildlife, industrial consumption, agricultural consumption, recreation and other uses. Where possible, these general classes are further divided into categories to provide protection, for example, to the different types of recreation.

CLASS 1: DOMESTIC CONSUMPTION defines objectives that will ensure the protection of waters that are used for human consumption after treatment. All surface waters of Manitoba are susceptible to uncontrolled microbiological contamination, for example, by wildlife. Consequently, minimum treatment consisting of disinfection is required for all surface waters prior to consumption. Objectives are included for substances that may have

harmful health effects, such as pesticides, toxic metals and radioactive materials and for substances that may present a nuisance to the consumer, such as excessive hardness and iron.

CLASS 2: AQUATIC LIFE AND WILDLIFE will ensure the protection of waters that are inhabited by aquatic life such as fish, amphibians (frogs), reptiles (turtles) and other forms of life including aquatic insects and algae. By ensuring protection of the aquatic communities, protection is indirectly offered to those forms of wildlife that rely upon surface waters for habitat and for food supplies. These include ducks, geese, furbearing mammals such as the muskrat and birds of prey such as the eagle and osprey. Protection is also provided to those animals that use these waters for drinking purposes.

Objectives are included for numerous parameters including dissolved oxygen, toxic metals and pesticides. The presence of dissolved oxygen in water is essential for aquatic life, and the type of aquatic community is dependent to a large extent on the amount of dissolved oxygen present. Toxic metals, such as zinc and cadmium, in small concentrations, can have harmful effects on growth and reproduction, and in large concentrations, can be lethal. Others, such as mercury and PCB's, even though present in small quantities, can slowly bio-accumulate in the tissue of organisms, until higher harmful levels are reached such that the fisheries resource becomes unsuitable for human consumption.

Some metals, such as cadmium, are more or less toxic depending upon the hardness of the water. For this reason, a mathematical equation is used to establish an objective based upon the relationship between toxicity and hardness.

The existence and composition of an aquatic community also depends upon temperature characteristics. An excessive increase in temperature can be harmful by interfering with fish spawning cycles, causing changes in growth and respiration, and causing more heat tolerant species to replace heat sensitive ones. Heat related winter fish kills can occur when a heated discharge is suddenly stopped. Fish that have been attracted to a heated area are suddenly exposed to the cold ambient temperature.

Developing site-specific temperature objectives is complex and time consuming. Therefore, a method is included by which temperature objectives will be developed for specific discharges.

CLASS 2: AQUATIC LIFE AND WILDLIFE is subdivided into two categories in order to provide specific protection to different general groups of aquatic life in Manitoba.

CATEGORY A: COLD WATER AQUATIC LIFE, COOL WATER AQUATIC LIFE AND WILDLIFE defines objectives that will provide protection to all types of aquatic life inhabiting the surface waters of Manitoba, including the protection of wildlife.

CATEGORY B: COOL WATER AQUATIC LIFE AND WILDLIFE defines objectives that will provide protection to cool water aquatic life such as walleye, sauger and pike, including the protection of wildlife. This category, however, will not provide adequate protection to cold water aquatic organisms such as trout and whitefish.

CLASS 3: INDUSTRIAL CONSUMPTION defines objectives that will ensure the protection of waters that are used for industrial purposes. However, objectives will not be developed at present due to the large number of present and potential industrial users, each with different quality requirements for water.

CLASS 4: AGRICULTURAL CONSUMPTION defines objectives that will provide protection to waters used by the market garden and farming industries for irrigation and livestock watering purposes. Objectives are included for parameters, such as sodium, that will protect variously textured soils. Other objectives, such as boron, will protect sensitive plants. In addition, others, for example, fecal coliform bacteria, are included that are intended to protect humans following consumption of raw vegetables irrigated with waters of this class.

This class is subdivided into four categories in order to provide protection to three different general irrigation practices plus to provide protection for livestock watering.

CATEGORY A: GREENHOUSE IRRIGATION defines objectives that will provide protection to waters that are used by the greenhouse industry where such water is the only source of moisture for the greenhouse plants.

CATEGORY B: FIELD CROP IRRIGATION defines objectives that will provide protection to waters that are used to irrigate field crops, where such water is used to supplement natural rainfall.

CATEGORY C: FIELD CROP IRRIGATION defines objectives that will provide protection to waters that are used to irrigate field crops, where such water is used to supplement natural rainfall. These waters, however, may damage certain soil types if used for long periods of time.

CATEGORY D: LIVESTOCK defines objectives that will provide protection to waters that are used by livestock for drinking purposes.

CLASS 5: RECREATION defines objectives that will ensure that surface waters may be safely used for swimming and boating purposes and also may provide for the enjoyment of pleasant scenery. These waters provide outdoor recreational opportunities for both Manitoba residents and for tourists.

This class is further subdivided into two categories in order to provide protection to the different types of water related recreation depending upon the extent of contact with the water.

CATEGORY A: PRIMARY RECREATION defines objectives that will ensure the protection of waters that may be used for purposes such as swimming and water skiing, where contact with the water is an important aspect of the activity.

CATEGORY B: SECONDARY RECREATION defines objectives that will ensure the protection of waters that may be used for purposes such as fishing and boating, where contact with the water is only incidental to the activity.

CLASS 6: OTHER USES: Manitoba's surface waters may be used for other purposes that do not require protection through the establishment of objectives. These include, for example, the disposal of wastes or the generation of hydroelectrical power. Because of social or economic reasons, certain waters may be used only for these uses.

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APPENDIX 1

Percent un-ionized ammonia in total ammonia solution for temperature and pH ranges of 0 to 30°C and 6 to 10 pH units respectively.

ABBREVIATIONS

(a) Bq/L = Becquerels per liter
(b) µg/L = micrograms per liter
(c) mg/L = milligrams per liter
(d) µS/cm = microsiemens per centimeter
(e) SAR = Sodium Adsorption Ratio

$$= \frac{0.044\ Na}{\sqrt{0.025\ Ca + .041\ Mg}}\ ,$$

expressed in mg/L

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PREAMBLE

In 1976, the Department of Environment and Workplace Safety and Health prepared a proposal outlining a system of surface water quality objectives and watershed classifications for the Province of Manitoba that would form the basis of a surface water quality management program. This proposal was critically reviewed by the Clean Environment Commission through public hearings held in 1977, under Section 13.1 of the Clean Environment Act. It was subsequently implemented with several revisions resulting from the public hearings.

Numerous revisions to this original system were proposed in 1983. These proposed revisions were circulated widely within Manitoba and Canada and comments were invited. Additionally, the Clean Environment Commission convened a public hearing in Winnipeg, during November 1984 in order to ensure that all interested or concerned individuals and agencies had the opportunity to provide critical comments or support in a public forum. Further revisions were proposed for a number of parameters during 1986 and were circulated to a number of industries, municipalities, recognized technical experts and the Clean Environment Commission. The attached document reflects the nature of most of the information obtained during these reviews. Revisions will continue to be made in the future as more experience is gained and as more scientific information becomes available.

This document consequently reflects the best scientific judgement of the Department of Environment and Workplace Safety and Health with regard to protecting the various uses of Manitoba's surface waters.

A second integral aspect of this surface water quality management activity involves an administrative procedure entitled watershed classification. Watershed classification is a management process whereby surface water quality objectives are applied to individual streams, stream segments, lakes, other water courses or entire watersheds in order to maintain, protect or enhance the beneficial uses of those waters. This process is discussed in a separate document.

The attached document has been prepared by the Water Standards and Studies Section of the Department of Environment and Workplace Safety and Health and has been extensively reviewed by the Water Pollution Control Section of the Department of Environment and Workplace Safety and Health, the Manitoba Departments of Agriculture, Municipal Affairs, Health, Urban Affairs, Business Development and Tourism, Energy and Mines, Industry, Trade and Technology and the Parks, Wildlife, Resource Allocation and Economics, Fisheries and Water Resources Branches of the Manitoba Department of Natural Resources. This document has also been reviewed by staff within the Canada Departments of Environment and Fisheries and Oceans, by municipal and industrial corporations, consulting agencies and private individuals as well as by the Manitoba Environment Council and the Clean Environment Commission.

FOR FURTHER INFORMATION ON THE SURFACE WATER QUALITY OBJECTIVES PLEASE CONTACT:

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Figure 1: Pisew Falls, located on the Grass River, is one of Manitoba's many picturesque water-related sites.

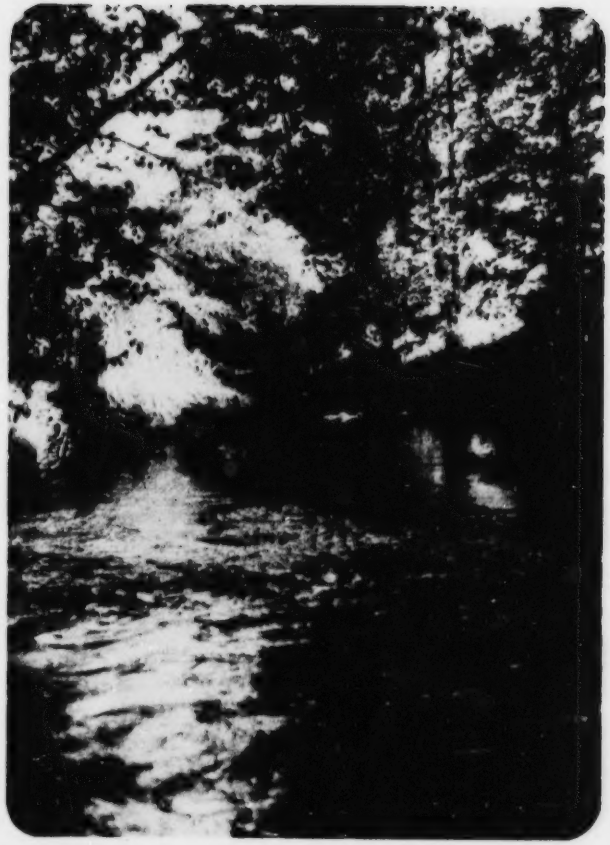

Figure 2: This tributary to the Shell River flows for only a short period of time each year, thus, is considered an intermittent stream.

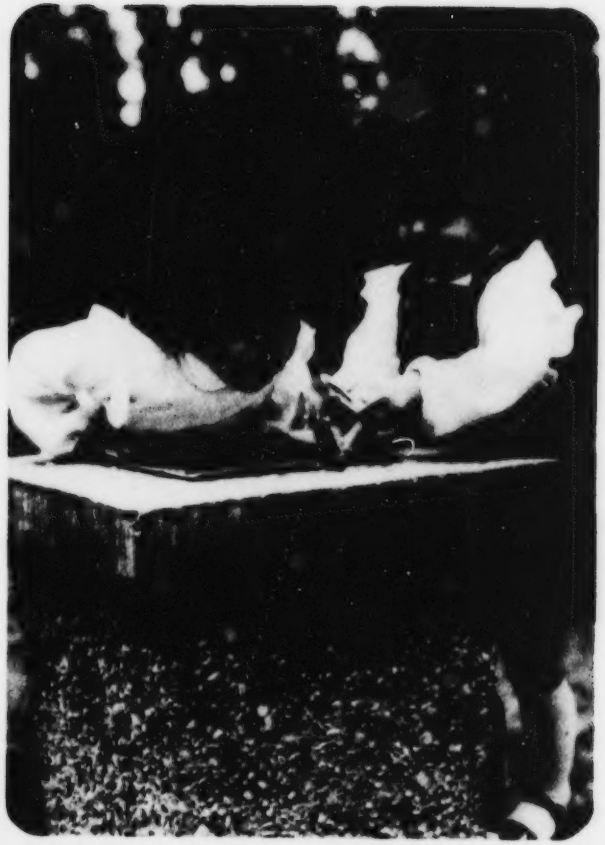

Figure 3: Water for domestic consumption should be safe, palatable and aesthetically pleasing.

1. INTRODUCTION

There are many diverse uses of surface waters within Manitoba, such as domestic, industrial and agricultural consumption, propagation and maintenance of aquatic life, wildlife, waterfowl, shorebirds and furbearing animals and recreation. These often require waters of differing physical, chemical and biological quality. These uses, plus others such as the disposal of wastes, generation of hydroelectrical power, removal of excess precipitation, hydraulic alterations to natural watercourses and land-use practices compete for the quality resources of provincial surface waters.

The acceptability of water is directly related to the needs of the user. Water containing a certain combination of constituents may be suitable for one use but may be totally unsuitable for another use.

The Department of Environment and Workplace Safety and Health is striving to maintain, enhance and protect the chemical, physical and biological integrity of all surface waters within the Province of Manitoba. Achievement of this goal will ensure that the present and potential surface water uses are maintained in concordance with the social and economic development of the Province. To this end, surface water quality objectives were formulated which define minimum levels of quality required for the various uses. Provincial waters designated "High Quality" will be afforded greater protection and waters designated "Exceptional Value" will be maintained in their natural or non-degraded state.

If the objectives do not offer adequate protection, surface water quality may become degraded, or if they are too restrictive, an unnecessary burden may be imposed on taxpayers and industry in order to pay for additional waste treatment facilities. These objectives, therefore, impact all Manitobans, since they may affect the operation of industries, municipalities and certain aspects of agriculture.

Surface water quality objectives are designated concentrations of constituents that, when not exceeded, will protect an organism, a community

of organisms, a prescribed water use, or a designated multiple purpose water use with an adequate degree of safety.

Where water quality parameters could not be defined in quantitative terms due to the lack of scientific information, general narrative statements were developed that reflect the necessary and desirable quality.

1.1 APPLICATION OF SURFACE WATER QUALITY OBJECTIVES

Surface water quality objectives are used as a management tool suited to protecting surface water quality. The objectives are used in conjunction with ambient monitoring data:

(a) to assist project planners to determine the wastewater treatment requirements likely associated with any specific location. Water quality objectives can be used for this purpose in conjuncton with other information such as downstream waters uses, existing water quality characteristics, and stream discharge volumes.

(b) to develop effluent discharge limitations for the protection of specific uses, through determining the capability of a receiving water course to assimilate waste pollutants. The assimilative capacity is usually determined by appropriate modelling techniques or, where possible, through site-specific assimilation studies. Initial dilution calculations are also useful in order to estimate the difference between objective levels and ambient levels, where the ambient concentrations are lower. However, both methods have disadvantages, since, for many pollutants, assimilation modelling techniques have not been accurately developed, and reliance solely upon dilution calculations may result in the transport of certain constituents to other parts of the aquatic ecosystem, where they may accumulate to harmful concentrations.

(c) to develop rational policies to guide those agencies having legislative authority, in co-operation with the Department of Environment and Workplace Safety and Health, for projects

involving resource apportionment, such as hydrological alterations and land-use practices that may contribute to water quality deterioration. Such projects include, but are not limited to:

(i) water flow augmentation,
(ii) lake level regulation,
(iii) water flow regulation,
(iv) inter-basin water transfer,
(v) extraction and apportionment of water for agriculture, municipal and industrial purposes,
(vi) construction activities,
(vii) resource harvesting or extraction operations (timber harvest, wild rice harvest, mineral exploration, mining, etc.),
(viii) apportionment of crown, municipal, or private lands for recreational or other purposes through lease, sale, subdivision, etc.

(d) to develop best management practices to control non-point or diffuse sources of pollution,
(e) to assess the effectiveness of pollution control measures in protecting beneficial uses,
(f) to identify if the ambient water can sustain specific uses, and
(g) to determine the significance of future water quality changes.

Paramount among the above applications, is the utilization of the objectives to develop effluent discharge limitations necessary to make discharges compatible with specific surface water uses. Many other additional factors are also simultaneously considered while developing effluent discharge limitations. These include, for example, administrative or technological practicalities, allocation of assimilative capacity between existing dichargers, and allocation of a proportion of assimilative capacity for future growth and development. Water quality objectives are also used in conjunction with other provincial and federal guidelines and regulations on quantities, rates and concentrations of chemical, physical, biological

and other constituents to which dischargers are subject. The water quality objectives should not be construed as permitting any waste amenable to treatment or control to be discharged into any surface waters without treatment or control that could reasonably be expected.

If the water quality objectives are not met, there is no direct legal implication to the source of the contamination. Such a situation however, would indicate that administrative action is required to determine the cause and if remedial action is required. For example, remedial action may involve the review and revision of discharge orders or licenses if point source discharges are the causative agents.

1.2 NATURAL CHARACTERISTICS OUTSIDE THE OBJECTIVES

Waters may have natural characteristics outside certain objectives. In such cases, the objectives for those parameters do not apply. The objectives contained herein apply to man-induced alterations. Withdrawal and subsequent discharge of such waters without alteration of the physical, chemical or biological characteristics into the same or similiar water body will not constitute exceedence of these objectives. The reduction in water quantity following withdrawal but prior to discharge however, should not cause exceedences of the general or specific surface water quality objectives such that other riparian uses may be adversely affected.

It should be noted that where a certain parameter exceeds its objective due to natural conditions, further deterioration by the introduction of pollutants should not be allowed, unless such additions will not jeopardise any beneficial use as shown through site-specific investigations.

1.3 LIMITATIONS AND INTERPRETATION OF SURFACE WATER QUALITY OBJECTIVES

The surface water quality objectives contained herein are based upon current scientific knowledge. Thus, they must be reviewed and revised

regularly to ensure that they reflect new information on criteria and limitations and that existing or potential uses are accurately identified.

There is a great deal of uncertainty of specific cause-effect relationships between all concentrations of pollutants and all environmental variables. In addition, information is scarce on the antagonistic, synergistic and additive effects of combinations of pollutants.

Utilization and implementation of these surface water quality objectives requires a thorough knowledge of the cause-effect relationships between pollutants and receptors. Transport mechanisms must be understood in order to determine the ultimate fate of pollutants within the aquatic environment. Because of the complex nature of this information, it is not possible to include all such material within this document. Further information therefore, may be required, such as from the referenced source documents, scientific literature or appropriate expert professionals.

While these water quality objectives are appropriate for most applications within Manitoba, unique conditions may exist at a specific site that would require objective modifications. Modifications of objectives could be required, for example, to account for the lower or greater sensitivity of resident aquatic species, or to consider the altered availability or toxicity of a pollutant due to the chemical or physical properties of the receiving water.

The objectives should be interpreted as maximum acceptable concentrations not to be exceeded at any time in any place, except where otherwise specified (i.e., low flow conditions, mixing zones). It should be noted that certain objectives are below the present technical detection capabilities of analytical instruments. This is justifiable, however, since these objectives are useful for calculating waste load limitations.

1.4 DEVELOPMENT OF SPECIFIC SURFACE WATER QUALITY OBJECTIVES

The list of specific water quality objectives does not include all possible substances that could affect water quality. For example, over 600 substances are registered by Agriculture Canada as active ingredients within pest control products. These products are used for various purposes including wood preservatives, insecticides, herbicides, fungicides, materials preservatives, plant growth regulators, etc., and are available for use in Manitoba. In addition, hundreds of other substances are recognized by the Department of Environment and Workplace Safety and Health as hazardous goods, and are subject to manufacture, use, storage or transport within Manitoba. These products therefore, have the potential to contaminate surface waters. When possible, analytical techniques and objectives will be developed given reasonable information that such substances are present. It should be noted however, that such analytical methods and objectives development is very costly and time consuming.

The general requirement from Section 1.7 that these should not be present in concentrations or combinations that injure, be toxic to, or produce unacceptable adverse physiological or behavioral responses in humans, aquatic, semi-aquatic and terrestrial life should apply to parameters not listed.

Specific numerical water quality objectives will be developed utilizing the best available scientific information. Objectives will be developed as follows for the protection of aquatic life:

1. Objectives will be developed utilizing the minimum data base concept published by the United States Environmental Protection Agency (U.S. EPA)(1) or subsequent similar methods.

Many of the objectives presently included were developed by this method. The method is predicated on the premise that all aquatic species need not be protected in all places at all times. Aquatic ecosystems can

tolerate some stress and can recover. A small fraction of organisms therefore, will not be afforded protection. This small fraction of sensitive organisms may be replaced through normal ecological succession by other, more tolerant forms within similar functional groups. The small fraction that does not require protection has been estimated to be 5% of the organisms listed by genera. In some cases, a lower percentile is required when this fifth percentile contains commercially or recreationally important species that would not be protected. Modifications can be implemented to similarly exclude other organisms such as numerical or ecological dominants or other important species. Consequently, some adverse effects are expected. The objectives are intended to avoid unacceptable adverse effects.

2. In those cases where it has been determined that there is insufficient available data to establish an objective for a pollutant that would prevent the occurrence of unacceptable adverse effects, an objective should be estimated by applying the appropriate application factor to the 96 hr LC_{50} value. The 96 hr LC_{50} is defined as that concentration of a toxic material or materials which kills fifty percent of bioassay test organisms in ninety-six hours. If an experimentally derived acute-chronic ratio or an application factor does not exist for a pollutant, the following values should be used in the determination of objective concentration values:
   (a) concentrations should not exceed the lowest chronic dose level at which unacceptable adverse effects were noted,
   (b) concentrations of pollutants that are non-persistent or have non-cumulative effects should not exceed 0.05 of the 96 hr LC_{50},
   (c) concentrations of pollutants that are persistent or have accumulative effects should not exceed 0.01 of the 96 hr LC_{50},
   (d) concentrations of pollutants with known synergistic or antagonistic effects with pollutants in the effluent or receiving water will be established on a case-by-case basis utilizing the best available scientific data.

Objectives for other uses will be developed utilizing the best available scientific information on exposure-response data, ingestion rates, risk extrapolation techniques, exposure from sources other than surface water, and appropriate safety factors dependent upon the quantity and quality of data.

1.5 HIGH QUALITY WATERS

Waters designated as "High Quality" should have biological, chemical and physical quality better than the established objectives. Such waters should support a high quality beneficial use. The designation "High Quality" will be used in conjunction with the respective beneficial use class or category that is determined to be of high quality. Waters suitable for inclusion are as follows:

(a) waters that flow through or that are bounded by Provincial or National Parks,

(b) waters within relatively undisturbed watersheds,

(c) waters possessing outstanding quality characteristics,

(d) waters that support a diverse or unique flora and fauna which are sensitive to man-induced water quality alterations,

(e) waters designated as Canadian Heritage Rivers.

Measurable or calculable degradation should not occur as a result of human activity, that will jeopardize the designated high quality use unless:

(a) the proposed new, additional or increased discharge or discharges of pollutants is justified,

(b) such proposed discharges will not preclude any use presently possible in such waters and downstream from such waters, and will not result in exceedences of the water quality objectives. Should the High Quality use involve the protection of aquatic life and wildlife, all life stages of all resident organisms likely to be affected will be protected. Consequently, the specific numerical objectives may be adjusted to reflect this additional degree of protection, and

(c) such proposed projects or developments which will result in new, additional or increased discharges of pollutants into such waters should be required to utilize the best available combination of treatment, land disposal, re-use and discharge technologies to control such wastes, including the use of best management practices to curb soil erosion.

This designation will be applied to specific areas only after public consultation, for example through public hearings, to ensure that all those likely to be affected can be consulted in order to avoid or resolve conflicts in use designation.

1.6 EXCEPTIONAL VALUE WATERS

Any water body whose quality is better than the established objectives and whose value as a resource for the support of a combination of aquatic life and wildlife and recreational uses is such that the waters are of exceptional recreational and ecological value will be given an "Exceptional Value" designation. Waters suitable for inclusion are as follows:

(a) Ecological Reserves,
(b) wild and scenic rivers or lakes,
(c) waters or watersheds providing habitat for rare or endangered flora and fauna,
(d) waters considered sensitive such that irreversible harm will result following human impact,
(e) waters whose exceptional quality and value as a future resource precludes the assignment of present uses,
(f) waters designated as Canadian Heritage Rivers.

The above waters will be given a single "Exceptional Value" designation. While principal consideration for Exceptional Value designation will be given the above waters, other exceptional value uses, such as domestic consumption, will also be considered. This designation will be used to replace all other possible beneficial use designations.

Water courses designated as such should not receive any alterations that result in measurable, calculable or perceived water quality degradation or degradation of other values deemed exceptional.

This designation will be applied to specific areas only after public consultation, for example through public hearings, to ensure that all those likely to be affected can be consulted in order to avoid or resolve conflicts in use designation.

1.7 GENERAL REQUIREMENTS

Because specific numerical objectives cannot reasonably be developed for every possible chemical, physical or biological parameter, the following general statements are also used to protect water quality. These statements, although written in general terms, are nevertheless water quality objectives. For example, these may be used to establish effluent limits even though there may be no specific numerical objectives applicable in the receiving water.

All surface waters of the Province of Manitoba such as streams, lakes, marshes, swamps, lowlands, etc., should be free of constituents attributable to sewage, industrial, agricultural and other land-use practices, or other man-induced point or non-point source discharges such that the following general objectives are met as minimum conditions at all times and in all places:

Parameter, Substance, or Condition	Objectives
Colour, odour, taste, turbidity	Free from materials that produce colour, odour, taste, turbidity or other conditions in such a degree as to be objectionable or to impair any beneficial use.
Deposits	None that will cause the formation of putrescent or otherwise objectionable sludge deposits.

Floating materials	Free from floating debris, scum, and other floating materials in sufficient amounts to be unsightly or deleterious.
Flow	Water quantities (flows and lake levels) should not be altered to a degree which will cause exceedences of the general or specific surface water quality objectives such that beneficial uses may be adversely affected.
Litter	Free from materials such as garbage, rubbish, trash, cans, bottles, or any unwanted or discarded solid material.
Nutrients	Nitrogen, phosphorus, carbon and contributing trace elements should be limited to the extent necessary to prevent the nuisance growth and reproduction of aquatic rooted, attached and floating plants, fungi or bacteria or to otherwise render the water unsuitable for other beneficial uses. For general guidance, unless it can be demonstrated that total phosphorus is not a limiting factor, considering the morphological, physical, chemical or other characteristics of the water body, total phosphorus should not exceed 0.025 mg/L in any reservoir, lake, pond, or in a tributary at the point where it enters such bodies of water. In addition, total phosphorus should not exceed 0.05 mg/L in any stream except those identified in the immediately preceding statement. It should be noted that maintenance of such concentrations may not guarantee that eutrophication problems will not develop.
Oil and grease	Free from oil and grease residues which causes a visible film or sheen upon the waters or any discolouration of the surface of adjoining shorelines or causes a sludge or

	emulsion to be deposited beneath the surface of the water or upon the adjoining shorelines.
Toxic substances	Free from substances in concentrations or in combinations that injure, be toxic to, or produce unacceptable adverse physiological or behavioral responses in humans, aquatic, semi-aquatic and terrestrial life.

1.8 MINIMUM AND MAXIMUM FLOWS AND LEVELS

Ideally, objectives should be maintained at all times. It is however, generally accepted that to require objective maintenance at all times is unreasonable. Thus, specific low flow levels have been chosen below which the objectives do not apply.

1.8.1 RIVERS AND STREAMS

The specific numerical water quality objectives should apply at all times except during periods when flows are less than the average minimum seven day flow which occurs once in ten years (Q_{7-10}). Should the average minimum seven day flow with a recurrence interval of once in ten years be 0.003 m^3/s or less, then the criteria from the following Section 1.8.2, INTERMITTENT STREAMS should apply. In cases where the stream flow is highly regulated it may not be possible to calculate the average minimum seven day flow with a recurrence interval of once in ten years. In such instances the specific numerical objectives should apply for all periods above the minimum daily discharge for the period of record after the stream flow was altered, or the minimum flow anticipated as a result of the water quantity management policy for that stream, in the best professional judgement of the Water Resources Branch, Manitoba Department of Natural Resources.

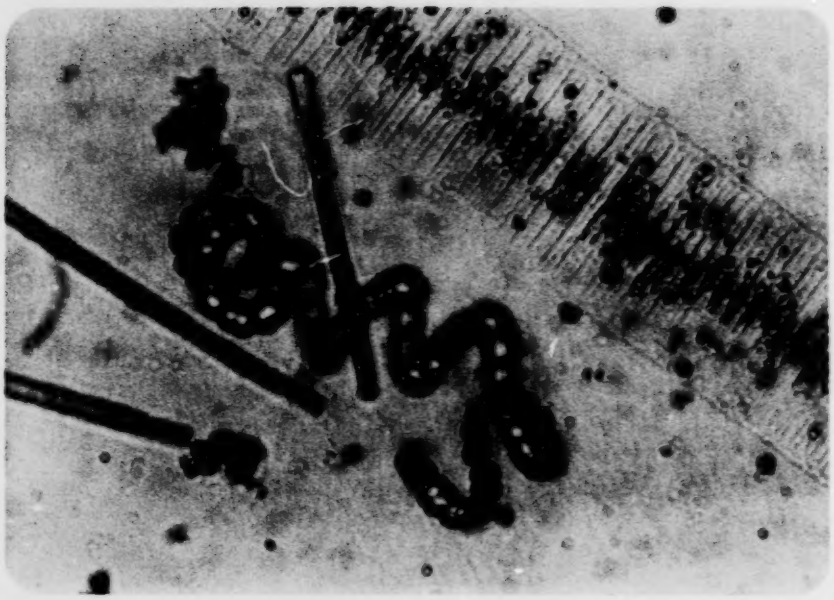

Figure 4: These various species of algae form an important link in the food chain of higher organisms, such as fish. However, given the necessary enriched conditions, algae may proliferate until nuisance conditions are reached.

Figure 5: Manitoba's surface waters abound with species of fish such as this pearl dace. Larger forage fish, such as walleye, rely upon these plus many other species as a source of food supply.

Figure 6: Amphibians, such as this leopard frog, rely upon surface waters for habitat and for sources of food supplies.

Figure 7: Waterfowl are often seen in association with Manitoba's lakes and marshes.

The specific numerical objectives should, however, apply at all times if the beneficial uses are supported because of pooling of water during periods of low natural flows. The general requirements from the preceding Section 1.7 should apply at all times regardless of the amount of flow. Minimum and maximum stream flow criteria may be developed on a site-specific basis should fluctuating stream flows influence water quality such that beneficial uses will be jeopardized.

1.8.2 INTERMITTENT STREAMS

Intermittent streams and natural or man-made drainage channels receive water from precipitation from small watersheds (usually less than 1 km^2 in area), and from ground water sources, hence usually flow during short periods. Such streams however, are an integral part of the surface water resources of the Province of Manitoba. The specific numerical water quality objectives should apply to all such streams when the flow is 0.003 m^3/s or greater. When flow within intermittent streams is less than this flow, minimum levels of quality should be maintained in order to not exceed the objectives within downstream water bodies to which the intermittent stream is tributary. The specific numerical objectives should however, apply at all times if the beneficial uses are supported because of pooling during periods of low natural flows. The general requirements from the preceding Section 1.7 should apply at all times regardless of the amount of flow. Minimum and maximum stream flow criteria may be developed on a site-specific basis should fluctuating stream flows influence water quality such that beneficial uses will be jeopardized.

1.8.3 LAKES, BAYS, MARSHES, SLOUGHS, IMPOUNDMENTS AND OTHER WETLANDS

The surface water quality objectives should apply at all times to lakes, bays, marshes, sloughs, impoundments and other wetlands unless they are a defined part of an effluent system prior to the final discharge point. Site-specific water quality management strategies may be developed, delineating maximum and minimum levels, when natural or man-made lake level fluctuations cause water quality deterioration such that beneficial uses are jeopardized.

1.9 MIXING ZONES

Mixing zones are areas adjacent to a discharge or to an activity that may affect water quality where a receiving water may not meet all the water quality objectives. This is allowed for practical reasons, since for most pollutants, it would be unreasonable to expect the objectives to be met at the end of the discharge pipe. Wastes and water are given an area to mix such that the water quality objectives are met at the boundaries of the mixing zone. Mixing zones are recognized as areas subject to loss of value. Such areas should not be construed as a substitute for waste discharge treatment.

Mixing zones should be determined on a case-by-case basis utilizing a thorough knowledge of local conditions. Normally, geometric size constraints will not be assigned due to the complex nature of the mixing properties of liquids. The following guidelines should apply to mixing zones where applicable, in order to minimize the loss of value such that beneficial water uses are not unacceptably impaired:

(a) the mixing zone should be as small as practicable and should not be of such size or shape as to cause or contribute to the impairment of water uses outside the zone,

(b) the mixing zone should be designed to allow an adequate zone of passage for the movement or drift of all stages of aquatic life,

  (i) for those materials that elicit an avoidance response from aquatic life the mixing zone should contain not more than 25% of the cross-sectional area or volume of flow at any transect in the receiving water. Should a proportion of the stream width greater than 25% be selected for these materials, the mixing zone could act similar to a physical barrier and could effectively preclude the passage of aquatic life,

  (ii) the mixing zone should not be acutely lethal to aquatic life passing through the mixing zone. Thus, acute lethality within the mixing zone is a function of the concentration of a toxic material and the duration of exposure,

(iii) mixing zones should not interfere with the migratory routes essential to the reproduction, growth or survival of aquatic species,

(iv) mixing zones should not cause an irreversible organism response, or increase the vulnerability to predation,

(v) when two or more mixing zones are in close proximity, they should be so defined that a continuous passageway for aquatic life is available,

(vi) mixing zones should not intersect the mouths' of rivers,

(c) mixing zones should not interfere with spawning and nursery areas,

(d) in lakes and other surface impoundments, the volume of mixing zones should not exceed 10% of the volume of that portion of the receiving waters available for mixing,

(e) mixing zones should not contaminate natural sediments so as to cause or contribute to exceedences of the water quality objectives outside the mixing zone,

(f) mixing zones should not intersect domestic water supply intakes or bathing areas,

(g) the general requirements from the preceding Section 1.7, where applicable, should apply at all points within the mixing zones such that objectionable nuisance conditions are avoided and that uses outside the mixing zone are not unacceptably impaired.

2. BENEFICIAL USES

The following sections are separated into classes that represent general surface water uses within Manitoba. These include domestic consumption, aquatic life and wildlife, industrial consumption, agricultural consumption, recreation and other uses. Where possible, these general classes are further divided into categories to provide protection, for example, to the different types of recreation.

2.1 CLASS 1: DOMESTIC CONSUMPTION

This class defines objectives that will ensure the protection of waters that are suitable for human consumption, culinary or food processing purposes and other household purposes.

The specific requirements listed hereunder are a combination of maximum acceptable concentrations and objective concentrations recommended in the document "Guidelines for Canadian Drinking Water Quality," 1978 (2), published by Health and Welfare Canada, and guidelines utilized by the Province of Manitoba. Inherent in these requirements is the necessity to disinfect all raw surface water supplies as minimum treatment prior to consumption, since all surface waters are susceptible to uncontrolled microbiological contamination, for example, by wildlife.

Some surface waters of the Province of Manitoba normally exceed several of these requirements due to natural or background occurences. Partial, complete or a combination of conventional and unit processes then become necessary in order to produce potable water from such raw water supplies. Specific requirements will not be developed for every possible combination of existing or available treatment processes.

Rather, it is the intent that man-induced water quality alterations not cause an unacceptable increased risk to public health or an unacceptable increased treatment cost to the water user or supplier. The following

maximum acceptable objectives should be used, on a site-specific basis, to assist in determining when increased health risks or increased treatment costs may be expected, in conjunction with information concerning:

(a) the chemical, physical or biological quality of the proposed discharge or alteration being considered,

(b) ambient or background surface water quality,

(c) design of downstream water treatment facilities,

(d) other pertinent information.

2.1.1 SPECIFIC REQUIREMENTS

2.1.1.1 RECOMMENDED LIMITS FOR PHYSICAL CHARACTERISTICS

Parameter	Maximum Acceptable
Colour	15 True Colour Units
Odour	Inoffensive
pH	6.5 - 8.5 pH Units
Taste	Inoffensive
Turbidity	5 Nephelometric Turbidity Units

2.1.1.2 RECOMMENDED LIMITS FOR CHEMICAL SUBSTANCES RELATED TO HEALTH

Substance[a]	Maximum Acceptable
Inorganic	
Antimony	0.0002 mg/L
Arsenic	0.05 mg/L
Barium	1.0 mg/L
Boron	5.0 mg/L
Cadmium	0.005 mg/L

Chromium	0.05	mg/L
Cyanide (Free)	0.2	mg/L
Fluoride	1.5	mg/L
Lead	0.05	mg/L
Mercury	0.001	mg/L
Nitrate (as N)[b]	10.0	mg/1
Nitrite (as N)[b]	1.0	mg/L
Selenium	0.01	mg/L
Silver	0.05	mg/L
Sodium	400.	mg/L
Sulphate	500.	mg/L
Uranium	0.02	mg/L

Organic

Nitrilotriacetic Acid (NTA)	0.05	mg/L
Pesticides (Total)[c]	0.1	mg/L
Trihalomethanes (Total potential)[d]	0.35	mg/L

a. Unless otherwise stated the limits refer to the sum of all forms present.

b. Where both nitrate and nitrite are present, the total nitrate, plus nitrite-nitrogen should not exceed 10 mg/L.

c. For maximum acceptable concentrations of individual pesticides see Section 2.1.1.3.

d. Comprise chloroform, bromodichloromethane, chlorodibromomethane and bromoform.

2.1.1.3 RECOMMENDED LIMITS FOR PESTICIDES

Pesticide[a]	Maximum Acceptable	
Aldrin and Dieldrin	0.0007	mg/L

Carbaryl	0.07	mg/L
Chlordane (Total Isomers)	0.007	mg/L
DDT (Total Isomers)	0.03	mg/L
Diazinon	0.014	mg/L
Endrin	0.0002	mg/L
Heptachlor and Heptachlor Epoxide	0.003	mg/L
Lindane	0.004	mg/L
Methoxychlor	0.1	mg/L
Methyl Parathion	0.007	mg/L
Parathion	0.035	mg/L
Toxaphene	0.005	mg/L
2, 4-D	0.1	mg/L
2, 4, 5 - TP	0.01	mg/L
Total Pesticides[b]	0.1	mg/L

a. The limits for each pesticide refer to the sum of all forms present.

b. The "Total Pesticides" limit applies to water in which more than one of the above pesticides is present, in which case, the sum of their concentrations should not exceed 0.1 mg/L.

2.1.1.4 RECOMMENDED LIMITS FOR SUBSTANCES RELATED TO AESTHETIC AND OTHER CONSIDERATIONS

Contaminant	Maximum Acceptable	
Chloride	250.	mg/L
Copper	1.0	mg/L
Hardness (as $CaCO_3$)	200.	mg/L
Hydrogen Sulfide (as H_2S)	0.05	mg/L
Iron	0.3	mg/L
Manganese	0.05	mg/L

Phenols	0.002 mg/L
Total Dissolved Solids	500. mg/L
Zinc	5.0 mg/L

2.1.1.5 RECOMMENDED LIMITS FOR RADIONUCLIDES

Radionuclides	Maximum Acceptable
Cesium - 137	50 Bq/L
Iodine - 131	10 Bq/L
Radium - 226	1 Bq/L
Strontium - 90	10 Bq/L
Tritium	
40000 Bq/L	

Where two or more radionuclides affecting the same organ or tissue are found to be present, the following relationship, based on the International Commission on Radiological Protection publication 26(3), should be satisfied:

$$\frac{c_1}{C_1} + \frac{c_2}{C_2} + \ldots \frac{c_i}{C_i} \leq 1$$

Where c_1, c_2, c_i are the observed concentrations, and C_1, C_2, C_i are the maximum acceptable concentrations for each contributing radionuclide.

2.1.1.6 RECOMMENDED LIMITS FOR MICROBIOLOGICAL CHARACTERISTICS

Indicator Organism	Maximum Acceptable
Fecal coliform bacteria	90 percentile: 10 organisms/100 mL
Total coliform bacteria	90 percentile: 100 organisms/100 mL

2.2 CLASS 2: AQUATIC LIFE AND WILDLIFE

2.2.1 CATEGORY A: COLD WATER AQUATIC LIFE, COOL WATER AQUATIC LIFE AND WILDLIFE

This category defines objectives that will ensure the passage, maintenance and propagation of fish species including the family Salmonidae (e.g., char, trout, whitefish, grayling) and additional flora and fauna which are indigenous to a cold water habitat. Application of the objectives from this category will also ensure the passage, maintenance and propagation of fish species and additional flora and fauna which are indigenous to a cool water habitat (e.g., mooneye, goldeye, pike, perch, walleye, sauger). Additional flora and fauna includes other aquatic organisms but not limited to bacteria, fungi, algae, aquatic insects, other aquatic invertebrates, reptiles, amphibians and fish.

By ensuring protection of the aquatic communities, protection is indirectly offered to those forms of wildlife that rely upon surface waters for habitat and for food supplies.

Application of the objectives from this category will therefore ensure the protection of streams, lakes, marshes, swamps, lowlands, etc. which are satisfactory as habitat for aquatic and semi-aquatic wild animals, such as waterfowl, shorebirds, furbearing mammals and other water oriented wildlife including the necessary aquatic organisms in their food chain. Protection of waters suitable for watering wild animals is provided.

Objectives are included for numerous parameters including dissolved oxygen, toxic metals and pesticides. The presence of dissolved oxygen in water is essential for aquatic life, and the type of aquatic community is dependent to a large extent on the amount of dissolved oxygen present. Toxic metals, such as zinc and cadmium, in small concentrations, can have

harmful effects on growth and reproduction, and in large concentrations, can be lethal. Others, such as mercury and PCB's, even though present in small quantities, can slowly bio-accumulate in the tissue of organisms, until higher harmful levels are reached.

Some metals, such as cadmium, are more or less toxic depending upon the hardness of the water. For this reason, a mathematical equation is used to establish an objective based upon the relationship between toxicity and hardness.

The existence and composition of an aquatic community also depends upon temperature characteristics. An excessive increase in temperature can be harmful by interfering with fish spawning cycles, causing changes in growth and respiration, and causing more heat tolerant species to replace heat sensitive ones. Heat related winter fish kills can occur when a heated discharge is suddenly stopped. Fish that have been attracted to a heated area are suddenly exposed to the cold ambient temperature.

Developing site-specific temperature objectives is complicated and time consuming. Therefore, a method is included by which temperature objectives will be developed for specific discharges.

2.2.1.1 SPECIFIC REQUIREMENTS

Parameter	Maximum Acceptable						
Ammonia (un-ionized, NH_3)(4)(5)[a]							
pH	0°C	5°C	10°C	15°C	20°C	25°C	30°C
6.50	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184
6.75	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184
7.00	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184
7.25	0.0184	0.0184	0.0134	0.0184	0.0184	0.0184	0.0184
7.50	0.0184	0.0184	0.0184	0.0186	0.026	0.026	0.026
7.75	0.0184	0.0184	0.022	0.031	0.043	0.043	0.043
8.00	0.0184	0.0184	0.025	0.035	0.050	0.050	0.050
8.25	0.0184	0.0184	0.025	0.035	0.050	0.050	0.050
8.50	0.0184	0.0184	0.025	0.035	0.050	0.050	0.050
8.75	0.0184	0.0184	0.025	0.035	0.050	0.050	0.050
9.00	0.0184	0.0184	0.025	0.035	0.050	0.050	0.050

Objectives can be interpolated for other ambient pH and temperature characteristics within the respective ranges of 6.50 to 9.00 and 0°C to 30°C with the following equations:

Ammonia Objective = 0.80/FT/FpH/Ratio[b]

Where FT = 1, when $T \geq 20°C$;

FT = $100.03(20-T)$, when $T < 20°C$;

FpH = 1, when $8 \leq pH \leq 9$;

$$FpH = \frac{1 + 10^{7.4-pH}}{1.25}, \text{ when } 6.5 \leq pH \leq 8;$$

Ratio = 16, when $7.7 \leq pH \leq 9$;

$$Ratio = \frac{24 \cdot 10^{7.7-pH}}{1+10^{7.4-pH}}, \text{ when } 6.5 \leq pH \leq 7.7.$$

a. The percent un-ionized ammonia can be calculated for any temperature and pH by using the following formula or table located in Appendix 1 (6):

$$f = \frac{1}{10^{(pKa - pH)} + 1} \times 100$$

where: f = the percent of the total ammonia in the un-ionized state,

pKa (dissociation constant for ammonia) = $0.09018 + \frac{2729.92}{(273.16 + °C)}$

°C = temperature in degrees Celsius

b. Except when FT • FpH • Ratio > 43.48; then 43.48 should be used as the denominator (this is a modification necessary to place a lower limit of 0.0184 mg/L on the objective rather than the original lower limit of 0.0007 mg/L un-ionized ammonia).

Arsenic (Acid-Soluble)(7)(5)	190 µg/L
Cadmium (Acid-Soluble)(8)	$e^{(0.7852[\ln(\text{hardness})]-3.490)}$, where hardness is expressed in mg/L as $CaCO_3$ and the resultant objective is expressed in µg/L(e.g.): 50 mg/L $CaCO_3 \equiv$ 0.66 µg/L 100 mg/L $CaCO_3 \equiv$ 1.1 µg/L 200 mg/L $CaCO_3 \equiv$ 2.0 µg/L
Chlordane (9)	0.0043 µg/L
Chlorine (Total residual) (10)	11 µg/L
Chromium (Acid-Soluble Hexavalent)(11)	11 µg/L
Chromium (Acid - Soluble Trivalent)(11)	$e^{(0.8190[\ln(\text{hardness})]+1.561)}$, where hardness is expressed in mg/L as $CaCO_3$ and the resultant objective is expressed in µg/L(e.g.):

	50 mg/L $CaCO_3$ ≡ 120 µg/L 100 mg/L $CaCO_3$ ≡ 210 µg/L 200 mg/L $CaCO_3$ ≡ 370 µg/L
Copper (Acid-Soluble)(12)	e(0.8545[ln(hardness)]-1.465), where hardness is expressed in mg/L as $CaCO_3$ and the resultant objective is expressed in µg/L (e.g.): 50 mg/L $CaCO_3$ ≡ 6.5 µg/L 100 mg/L $CaCO_3$ ≡ 12 µg/L 200 mg/L CaC)$_3$ ≡ 21 µg/L
Cyanide (Free, sum of HCN and CN^-, expressed as CN)(13)	5.2 µg/L
DDT and metabolites (14)	0.0010 µg/L
Dieldrin (15)	0.0019 µg/L
Dissolved oxygen (16)	60% saturation (instantaneous minimum)
Endosulfan (17)	0.056 µg/L
Endrin (18)	0.0023 µg/L
Heptachlor (19)	0.0038 µg/L
Hexachlorobutadiene (HCBD)(20)	0.1 µg/L
Hydrogen Sulphide (H_2S)(21)	0.002 mg/L
Iron (Total)(21)	1.0 mg/L
Lead (Acid-Soluble)(22)	e(1.273[ln(hardness)]-4.705), where hardness is expressed in mg/L as $CaCO_3$ and the resultant objective is expressed in µg/L (e.g.): 50 mg/L $CaCO_3$ ≡ 1.3 µg/L 100 mg/L $CaCO_3$ ≡ 3.2 µg/L 200 mg/L $CaCO_3$ ≡ 7.7 µg/L
Lindane (23)	0.080 µg/L

Mercury (Total) (24)(5)	0.006 µg/L
Nickel (Total Recoverable)(25)	$e^{(0.76[\ln(\text{hardness})]+1.06)}$, where hardness is expressed in mg/L as $CaCO_3$ and the resultant objective is expressed in µg/L(e.g.): 50 mg/L $CaCO_3$ ≡ 56 µg/L 100 mg/L $CaCO_3$ ≡ 96 µg/L 200 mg/L $CaCO_3$ ≡ 160 µg/L
Non-filterable residue (26)	25 mg/L
pH (26)	6.5 - 9.0 pH units
Phenols (21)	1.0 µg/L
Phthalic acid esters	
(i) Dibutylphthalate (DBP) (20)	4.0 µg/L
(ii) Di-(2-ethylhexyl) phthalate (DEHP)(20)	0.6 µg/L
(iii) Other phthalates (20)	0.2 µg/L
Polychlorinated biphenyls (27)	0.014 µg/L
Selenium (Total Recoverable selenite)(28)	35 µg/L
Silver (Total)(29)	0.1 µg/L
Temperature (21)	Site specific objectives will be developed considering the following: 1. Thermal additions should be such that thermal stratification and subsequent turnover dates are not altered from those existing prior to the addition of heat from artificial origin.

2. One limit which consists of a maximum weekly average temperature that:

   (a) in the warmer months is determined by adding to the physiological optimum temperature (usually for growth) a factor calculated as one-third of the difference between the ultimate upper incipient lethal temperature and the optimum temperature for the most sensitive important species (and appropriate life stages) that normally is found at that location and time,

   (b) in the colder months is an elevated temperature that would still ensure that important species would survive if the temperature suddenly dropped to the normal ambient temperature, or

   (c) during reproduction seasons meets specific site requirements for successful migration, spawning, egg incubation, and other reproductive functions of important species, or

   (d) at a specific site is found necessary to preserve normal species diversity or prevent undesirable growths of nuisance organisms.

3. A second limit which is the time-dependent maximum temperature for short exposures.

4. Maximum limits may be specified for incremental temperature fluctuations necessary to protect aquatic life from sudden temperature changes.

Toxaphene (30)	0.013 µg/L
Zinc (Total Recoverable) (31)	47 µg/L

2.2.2 CATEGORY B: COOL WATER AQUATIC LIFE AND WILDLIFE

This category defines objectives that will ensure the passage, maintenance and propagation of fish species and additional flora and fauna which are indigenous to a cool water habitat (e.g., mooneye, goldeye, pike, perch, walleye, sauger). This category also includes other aquatic organisms but is not limited to bacteria, fungi, algae, aquatic insects, other aquatic invertebrates, reptiles, amphibians and fishes that are indigenous to a cool water habitat.

Application of objectives from this category will also ensure the protection of streams, lakes, marshes, swamps, lowlands, etc. which are satisfactory as habitat for aquatic and semi-aquatic wild animals, such as waterfowl, shorebirds, furbearing mammals and other water oriented wildlife including the necessary aquatic organisms in their food chain. Protection of waters suitable for watering wild animals is provided.

2.2.2.1 SPECIFIC REQUIREMENTS

All parameters and limitations from Section 2.2.1.1 should apply except as follows:

Parameter	Maximum Acceptable
Dissolved oxygen (16)	47% saturation (instantaneous minimum)

2.3 CLASS 3: INDUSTRIAL CONSUMPTION

This class defines objectives that will ensure the protection of all waters which are or may be used as a source of supply for industrial processes or cooling water, or any other industrial or commercial purposes and for which quality control is or may be necessary.

Discharges or alterations to waters classified as CLASS 3: INDUSTRIAL CONSUMPTION, should not be permitted such that downstream present or potential industrial users will incur unacceptable additional treatment costs.

2.3.1 SPECIFIC REQUIREMENTS

Selective limits will be established for any specific water as required. Objectives will not be formulated at present due to the large number of present and potential industrial water users, each with varying requirements for quality control of water. Objectives will be developed when necessary using the industry specific requirements outlined in (32) with the necessary modifications required for site specificity.

2.4 CLASS 4: AGRICULTURAL CONSUMPTION

2.4.1 CATEGORY A: GREENHOUSE IRRIGATION

This category defines objectives that will ensure the long term protection of fine, medium and coarse textured soils from the accumulation of substances that may be harmful or cause a reduction in fertility; will ensure the protection of sensitive, semi-tolerant and tolerant species of plants; and will ensure the protection of humans from the harmful effects caused by the accumulation of substances on marketable produce that may not be processed prior to consumption. Application of objectives from this category will provide protection for intensive horticultural crop production, where irrigation is used as the only source of water.

Objectives are included for parameters such as sodium, that will protect various textured soils. Other objectives, such as boron, will protect sensitive plants. In addition, others, for example, fecal coliform bacteria are included that are intended to protect humans following consumption of raw vegetables irrigated with water of this class.

2.4.1.1 SPECIFIC REQUIREMENTS

Parameter	Maximum Acceptable
Aluminum (Total) (33)	5.0 mg/L
Arsenic (Total) (30)	0.1 mg/L
Beryllium (Total) (33)	0.1 mg/L

Boron (Total) (34)	0.5 mg/L
Cadmium (Total) (30)	0.01 mg/L
Chloride (Soluble) (34)	68 mg/L
Chromium (Total) (30)	0.1 mg/L
Cobalt (Total) (33)	0.05 mg/L
Conductivity (34)	1000 µS/cm
Copper (Total) (30)	0.2 mg/L
Fecal coliform bacteria (33)	geometric mean: 1000 organisms/100 mL (sufficient samples should be collected in order to permit valid interpretation). Should contact with the irrigation water by field staff be probable, the microbiological indicator organism characteristics from the following Section 2.5, CLASS 5: RECREATION, CATEGORY A: PRIMARY RECREATION should apply. It is recommended that vegetables irrigated with water of this class and normally consumed without cooking should be thoroughly washed with domestic consumption quality water. This will ensure the further protection of human health by removing all pathogenic micro-organisms from the vegetable surface contributed by the irrigation water or through handling procedures.
Filterable residue (34)	700 mg/L
Fluoride (Total) (33)	1.0 mg/L
Hydrogen sulfide (H_2S) (34)	3.0 mg/L
Iron (Total)(33)	5.0 mg/L
Lead (Total)(30)	5.0 mg/L
Lithium (Total) (33)	2.5 mg/L
Manganese (Total) (33)	0.2 mg/L
Molybdenum (Total) (33)	0.01 mg/L
Nickel (Total) (30)	0.2 mg/L

Figure 8: The La Salle River is used as a source of irrigation water for vegetable crops.

Figure 9: Many streams, such as the Shell River, are used for watering livestock. It is however, considered environmentally unacceptable to allow livestock direct access to the river.

Figure 10: Manitoba's surface waters provide an aesthetically pleasing setting for the enjoyment of secondary recreational pursuits, such as angling.

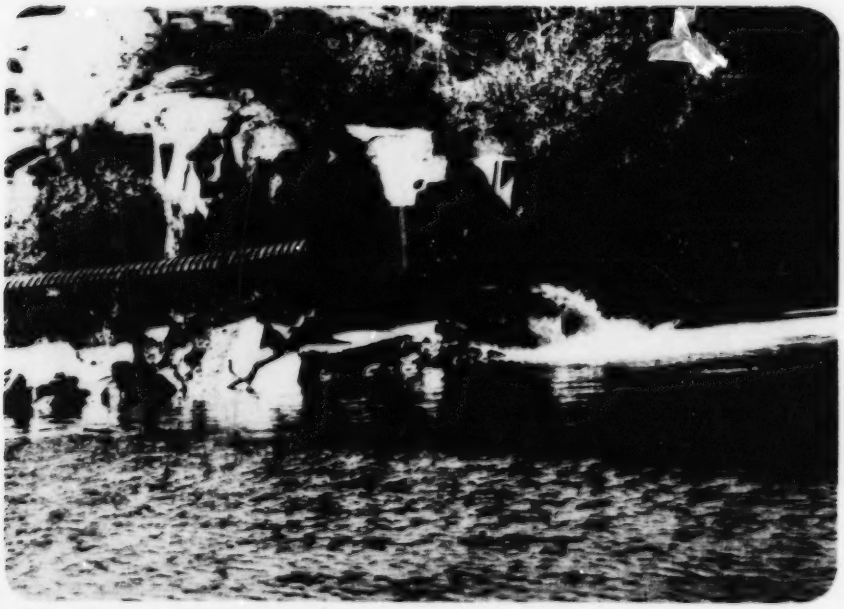

Figure 11: The assimilative capacity of streams, such as the Winnipeg River, is used to dispose of liquid waste effluents.

pH (34)	6.0-8.5 pH units
Radionuclides (4)	The limits from the preceding Section 2.1.1.5, RECOMMENDED LIMITS FOR RADIONUCLIDES should apply.
Selenium (Total) (30)	0.02 mg/L
Sodium (33)(34)	(a) 20 mg/L (b) 4.0 Sodium Adsorption Ratio (SAR)
Sulfates (34)	250 mg/L
Vanadium (Total) (33)	0.1 mg/L
Zinc (Total)(33)	2.0 mg/L

2.4.2 CATEGORY B: FIELD CROP IRRIGATION

This category defines objectives that will ensure the long term protection of fine, medium and coarse textured soils from the accumulation of substances that may be harmful or cause a reduction in fertility; will ensure the protection of sensitive, semi-tolerant and tolerant species of plants; and will ensure the protection of humans from harmful effects caused by the accumulation of substances on marketable produce that may not be processed prior to consumption. Application of objectives from this category will provide protection for field crop production where irrigation water is used to supplement natural precipitation. This category may be applicable only during the irrigation season.

2.4.2.1 SPECIFIC REQUIREMENTS

The maximum acceptable concentrations for parameters listed in the preceding Section 2.4.1.1 should apply with the following exceptions:

Parameter	Maximum Acceptable
Boron (Total) (34)	1.0 mg/L
Chloride (Soluble)(34)	150 mg/L
Conductivity (34)	1500 µS/cm
Filterable residue (34)	1050 mg/L

pH (34)	5.0-9.0 pH units
Sodium (33)	6.0 Sodium Adsorption Ratio (SAR)

2.4.3 CATEGORY C: FIELD CROP IRRIGATION

This category defines objectives that will ensure the long term protection of coarse soils, protection up to twenty years of medium to fine textured soils, and short term protection of fine textured soils from the accumulation of substances that may be harmful or cause a reduction in fertility; will ensure the protection of sensitive, semi-tolerant and tolerant species of plants; and will ensure the protection of humans from harmful effects caused by the accumulation of substances on marketable produce that may not be processed prior to consumption. Application of objectives from this category will provide protection for permanent irrigation installations on coarse soils and for temporary irrigation installations on medium to fine soils where irrigation water is used to supplement natural precipitation. Prolonged use of water of this class on medium to fine and fine textured soils will result in soil damage and subsequent loss of fertility. This category may be applicable only during the irrigation season.

2.4.3.1 SPECIFIC REQUIREMENTS

The maximum acceptable concentrations for parameters listed in the preceding Section 2.4.1.1 should apply with the following exceptions:

Parameter	Maximum Acceptable
Aluminum (Total) (33)	20.0 mg/L
Arsenic (Total) (33)	2.0 mg/L
Beryllium (Total) (33)	0.5 mg/L
Boron (Total) (33)	2.0 mg/L

Chromium (Total) (33)	1.0 mg/L
Cobalt (Total) (33)	5.0 mg/L
Conductivity (34)	2000 µS/cm
Copper (Total) (30)	5.0 mg/L
Filterable residue (34)	1400 mg/L
Fluoride (Total) (33)	15.0 mg/L
Iron (Total) (33)	20.0 mg/L
Lead (Total) (30)	10.0 mg/L
Manganese (Total) (33)	10.0 mg/L
Nickel (Total) (30)	2.0 mg/L
Selenium (Total) (30)	0.05 mg/L
Sodium (33)	8.0 Sodium Adsorption Ratio (SAR)
Vanadium (Total) (33)	1.0 mg/L
Zinc (Total) (33)	10.0 mg/L

2.4.4 CATEGORY D: LIVESTOCK

This category defines objectives that will ensure the protection of all classes and ages of livestock and poultry from inhibitory effects following water consumption. Adjustment problems, such as mild and temporary diarrhea, may result when the livestock are introduced to the water, but should not affect their health or performance. Disinfection may be required for waters heavily contaminated with wastes of fecal origin in order to provide a suitable supply for ingestion by monogastric animals (poultry, swine, horses).

2.4.4.1 SPECIFIC REQUIREMENTS

Parameter	Maximum Acceptable
Alkalinity (Total, as $CaCO_3$)[1] (35)	1000 mg/L
Aluminum (Total) (33)	5.0 mg/L
Arsenic (Total) (30)	0.5 mg/L
Boron (Total) (33)	5.0 mg/L
Cadmium (Total) (30)	0.02 mg/L
Chromium (Total) (30)	1.0 mg/L
Cobalt (Total) (33)	1.0 mg/L
Conductivity (35)	4300 µS/cm
Copper (Total) (33)	1.0 mg/L
Dissolved oxygen (33)	maintain aerobic conditions
Filterable residue (33)	3000 mg/L
Fluoride (Total) (33)	2.0 mg/L
Lead (Total) (30)	0.5 mg/L
Mercury (Total) (30)	0.003 mg/L
Nickel (Total) (30)	5.0 mg/L
Nitrate - Nitrite (34)	10.0 mg/L
pH (35)	5.5-9.0 pH units
Radionuclides (4)	The limits from the preceding Section 2.1.1.5, RECOMMENDED LIMITS FOR RADIONUCLIDES, should apply.
Selenium (Total) (30)	0.05 mg/L
Sulfate (SO_4)[a] (34)	600 mg/L

Toxic algae (35)	Waters bearing heavy growths of blue green algae should be avoided.
Vanadium (Total) (33)	0.1 mg/L
Zinc (Total) (30)	50.0 mg/L

a. Alkalinity (Total, as $CaCO_3$) plus Sulfate (SO_4) should not exceed 1000 mg/L (34).

2.5 CLASS 5: RECREATION

Surface waters provide outdoor recreational opportunities for both Manitoba residents and tourists. This class defines objectives that will ensure that such waters may be safely used for swimming and boating purposes and also may provide for the enjoyment of pleasant scenery.

2.5.1 CATEGORY A: PRIMARY RECREATION

This category defines objectives that will ensure the protection of waters which are suitable for primary recreational uses where the human body may come in direct contact with the water, to the point that water may be ingested accidently or water may contact certain sensitive organs such as the eyes, ears and nose. Examples could include wading and dabbling, swimming, diving, water skiing, surfing and intimate contact with water directly associated with shoreline activities. Due to climatic conditions in Manitoba, primary recreation is usually restricted to the period from May 1 to September 30 of the same year.

2.5.1.1 SPECIFIC REQUIREMENTS

Parameter	Maximum Acceptable
Clarity (Secchi disc visibility) (36)	1.2 meters (minimum)
Dissolved oxygen (37)	maintain aerobic conditions

Microbiological Indicator Organisms[a]	
(a) Escherichia coli (38)(5)	geometric mean: 200 organisms/100 mL
(b) Fecal Coliforms (36)(5)	geometric mean: 200 organisms/100 mL
pH (36)	6.5-8.5 pH units
Turbidity (36)	50 Jackson Turbidity Units

a. Please Note: Both indicators should provide equivalent protection. The geometric mean should be of sufficient samples in order to permit valid interpretation.

2.5.2 CATEGORY B: SECONDARY RECREATION

This category defines objectives that will provide protection to waters which are suitable for boating, fishing and other water related activities other than immersion recreation, including navigation and aesthetic enjoyment of scenery. Application of the objectives from this category will provide protection for activities in which water use is incidental, accidental or sensory, and includes fishing, boating, camping, hunting and hiking.

2.5.2.1 SPECIFIC REQUIREMENTS

Parameter	Maximum Acceptable
Dissolved oxygen (22)	maintain aerobic conditions
Fecal coliform bacteria (37)	geometric mean: 1000 organisms/100 mL (sufficient samples should be collected in order to permit valid interpretation).
Navigational hazards (37)	There should be no unmarked submergent or emergent obstructions that pose a threat to navigation.
Temperature (37)	There should be no temperature changes that interfere with the natural freezing patterns or dates that pose a threat to navigation.

2.6 CLASS 6: OTHER USES

The uses to be protected in this class may be those uses of waters under other jurisdictions and in other areas to which the waters of the Province are tributary and may include any or all of the uses listed in the preceding categories, plus any other possible beneficial uses. The Department of Environment and Workplace Safety and Health, therefore, reserves the right to designate any objective necessary for the protection of this class, consistent with legal limitations.

The Department of Environment and Workplace Safety and Health is also cognizant of the fact that other uses of streams, rivers or lakes may also include the removal of excess precipitation, production of hydroelectric power or disposal of wastes. These are beneficial uses, however, they do not require protection through the designation of objectives. These uses, however may be chosen on the basis of social or economic conditions to take precedence over the other preceding designated beneficial uses.

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APPENDIX 1

Table 1: Percent un-ionized ammonia in total ammonia solution for temperature and pH ranges of 0 to 30°C and 6 to 10 pH units, respectively (6).

Temp. (°C)	pH (pH units) 6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
0	.00827	.0261	.0826	.261	.820	2.55	7.64	20.7	45.3
1	.00899	.0284	.0898	.284	.891	2.77	8.25	22.1	47.3
2	.00977	.0309	.0977	.308	.968	3.00	8.90	23.6	49.4
3	.0106	.0336	.106	.335	1.05	3.25	9.60	25.1	51.5
4	.0115	.0364	.115	.363	1.14	3.52	10.3	26.7	53.5
5	.0125	.0395	.125	.394	1.23	3.80	11.1	28.3	55.6
6	.0136	.0429	.135	.427	1.34	4.11	11.9	30.0	57.6
7	.0147	.0464	.147	.462	1.45	4.44	12.8	31.7	59.5
8	.0159	.0503	.159	.501	1.57	4.79	13.7	33.5	61.4
9	.0172	.0544	.172	.542	1.69	5.16	14.7	35.3	63.3
10	.0186	.0589	.186	.586	1.83	5.56	15.7	37.1	65.1
11	.0201	.0637	.201	.633	1.97	5.99	16.8	38.9	66.8
12	.0218	.0688	.217	.684	2.13	6.44	17.9	40.8	68.5
13	.0235	.0743	.235	.738	2.30	6.92	19.0	42.6	70.2
14	.0254	.0802	.253	.796	2.48	7.43	20.2	44.5	71.7
15	.0274	.0865	.273	.859	2.67	7.97	21.5	46.4	73.3
16	.0295	.0933	.294	.925	2.87	8.54	22.8	48.3	74.7
17	.0318	.101	.317	.996	3.08	9.14	24.1	50.2	76.1
18	.0343	.108	.342	1.07	3.31	9.78	25.5	52.0	77.4
19	.0369	.117	.368	1.15	3.56	10.5	27.0	53.9	78.7
20	.0397	.125	.396	1.24	3.82	11.2	28.4	55.7	79.9
21	.0427	.135	.425	1.33	4.10	11.9	29.9	57.5	81.0
22	.0459	.145	.457	1.43	4.39	12.7	31.5	59.2	82.1
23	.0493	.156	.491	1.54	4.70	13.5	33.0	60.9	83.2
24	.0530	.167	.527	1.65	5.03	14.4	34.6	62.6	84.1
25	.0569	.180	.566	1.77	5.38	15.3	36.3	64.3	85.1
26	.0610	.193	.607	1.89	5.75	16.2	37.9	65.9	85.9
27	.0654	.207	.651	2.03	6.15	17.2	39.6	67.4	86.8
28	.0701	.221	.697	2.17	6.56	18.2	41.2	68.9	87.5
29	.0752	.237	.747	2.32	7.00	19.2	42.9	70.4	88.3
30	.0805	.254	.799	2.48	7.46	20.3	44.6	71.8	89.0